Feb. 25, 1964 — J. R. JARVIS — 3,122,009

LAUNDRY MACHINE

Filed Oct. 25, 1962 — 8 Sheets-Sheet 1

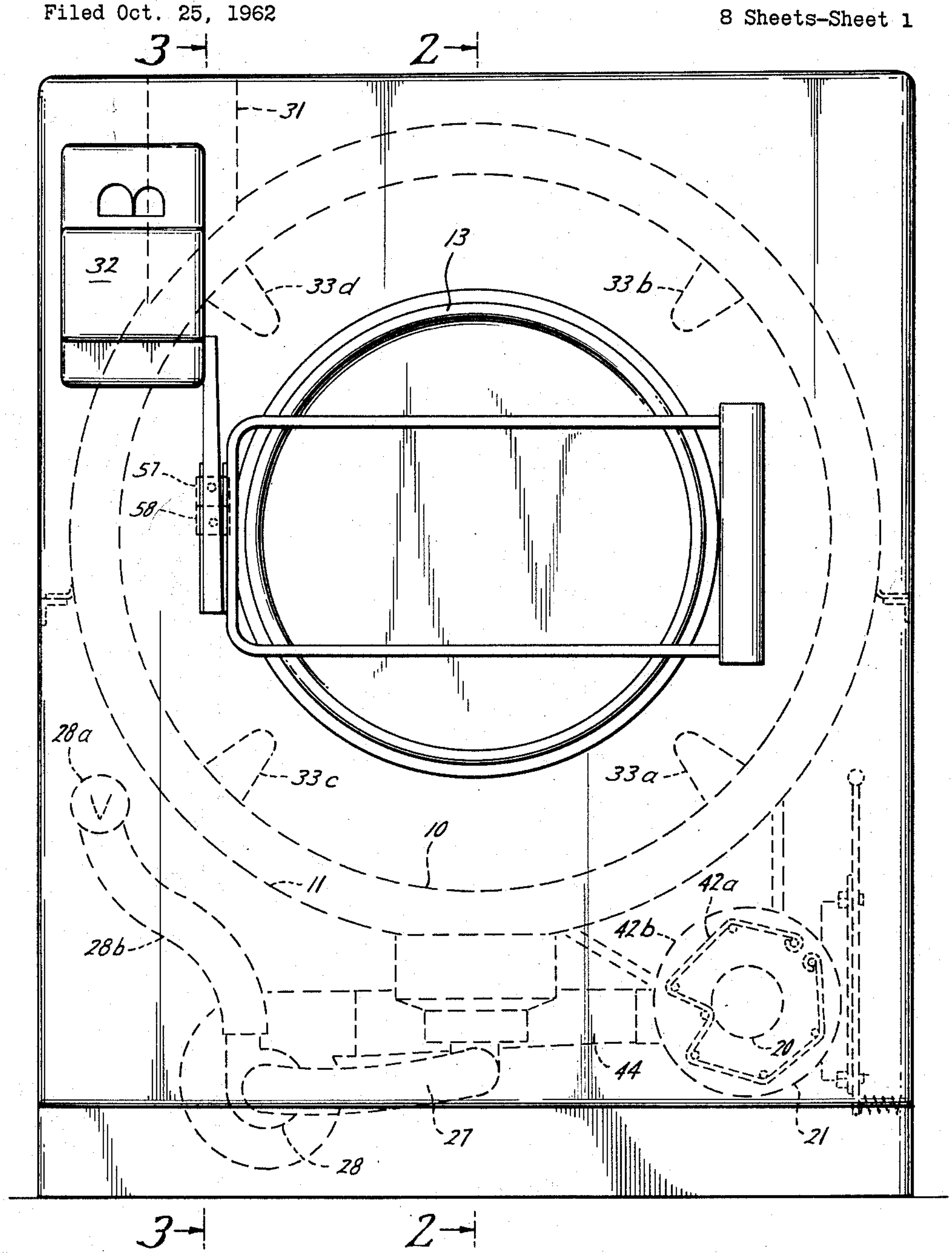

Fig. 1

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LAUNDRY MACHINE

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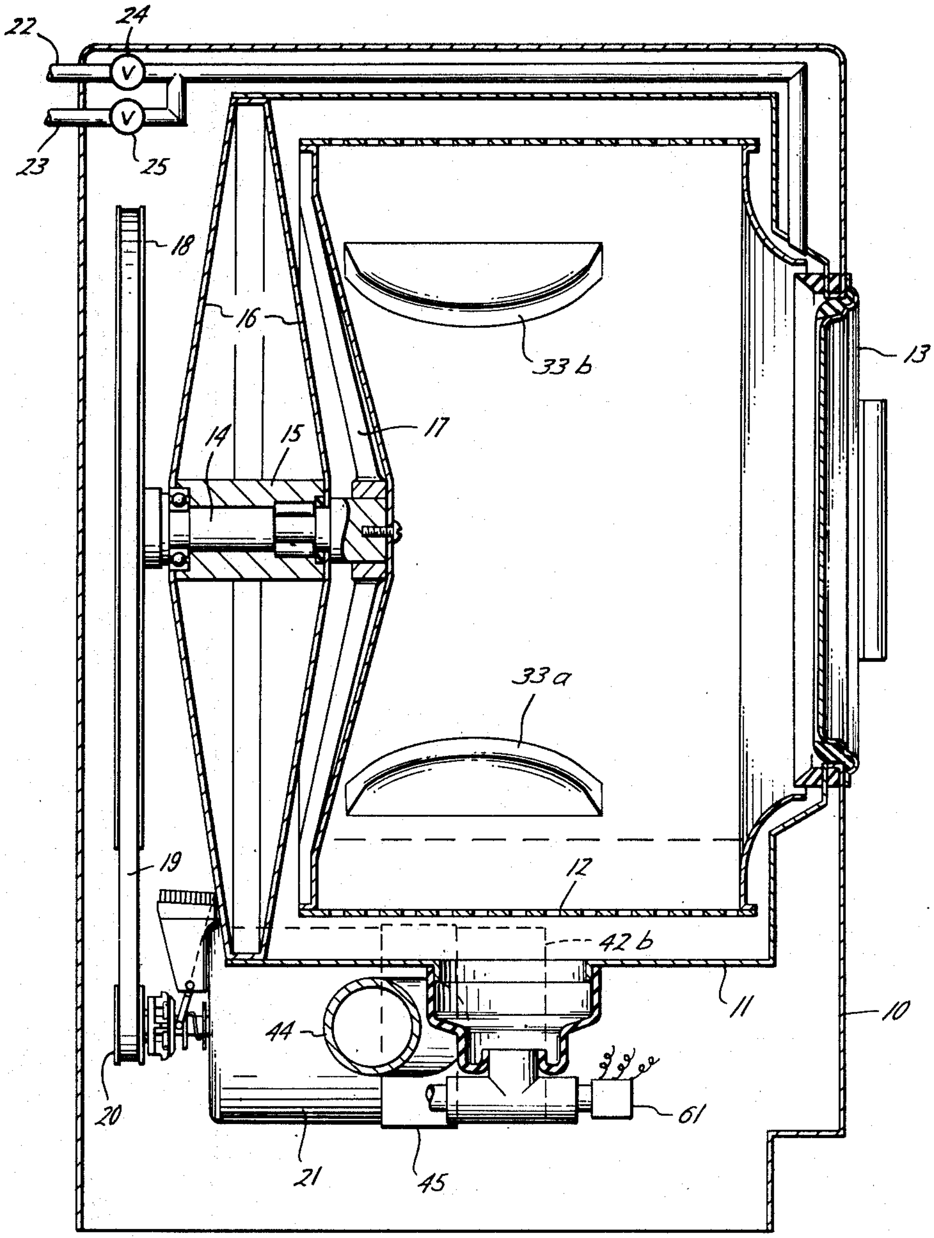

Fig. 2

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LAUNDRY MACHINE

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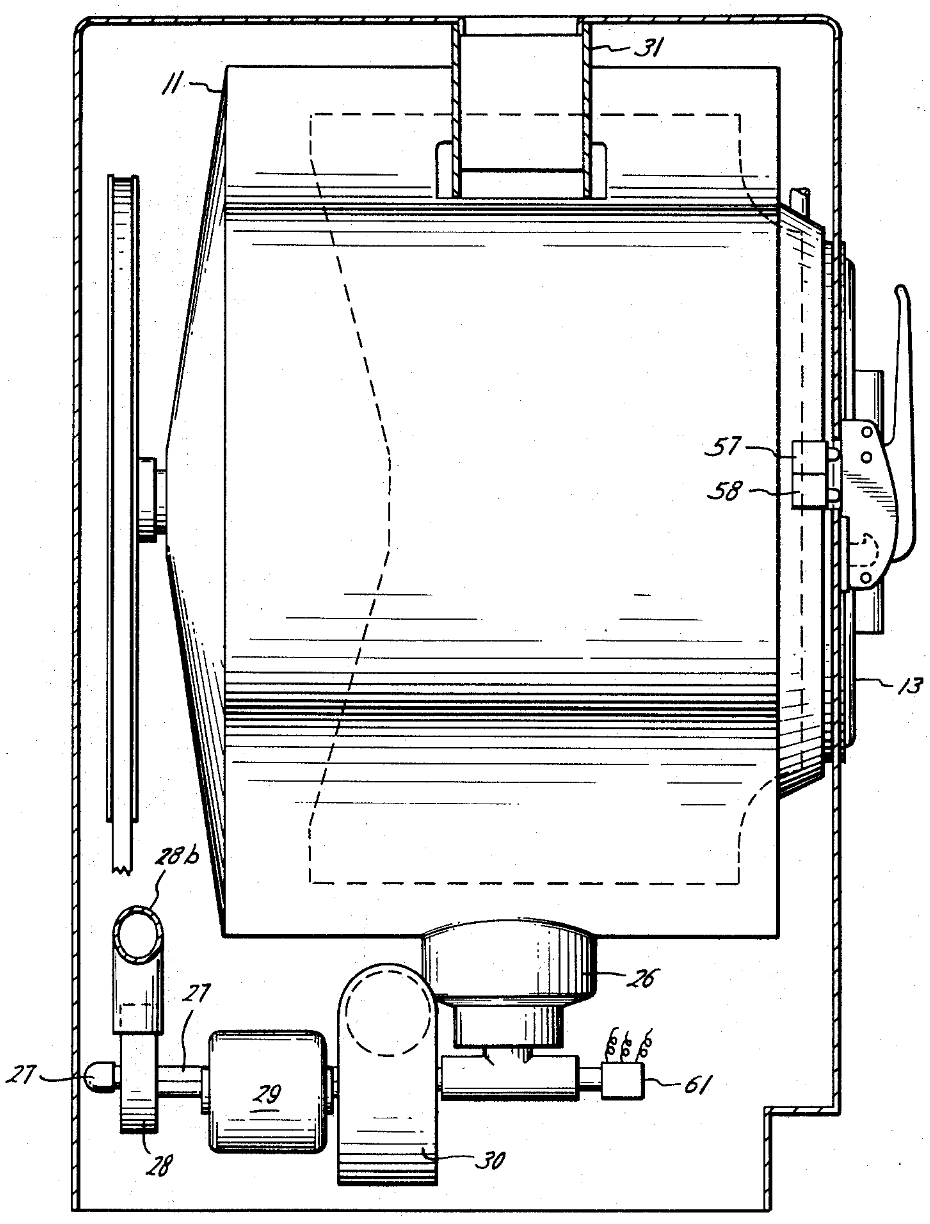

Fig. 3

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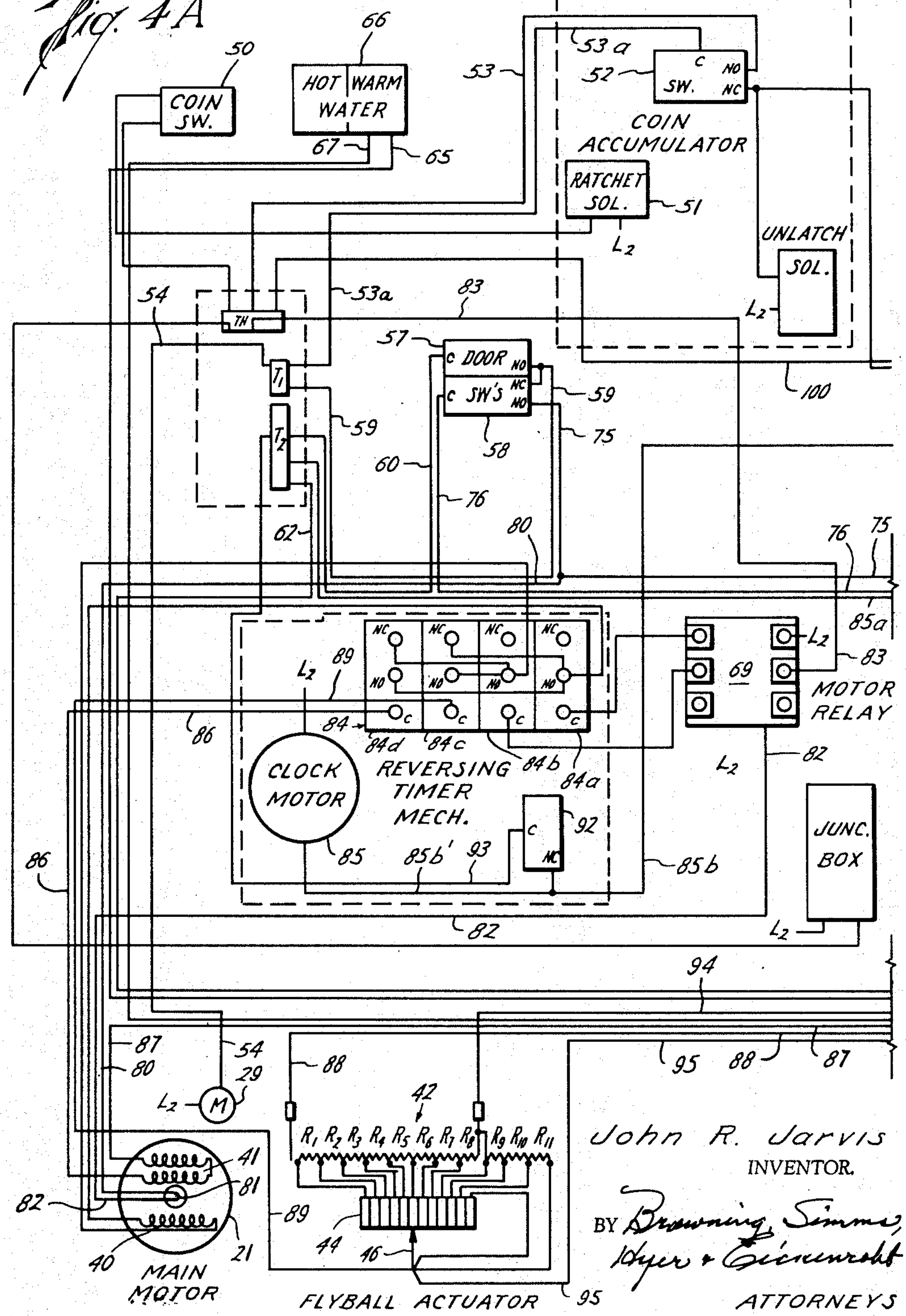
Fig. 4A



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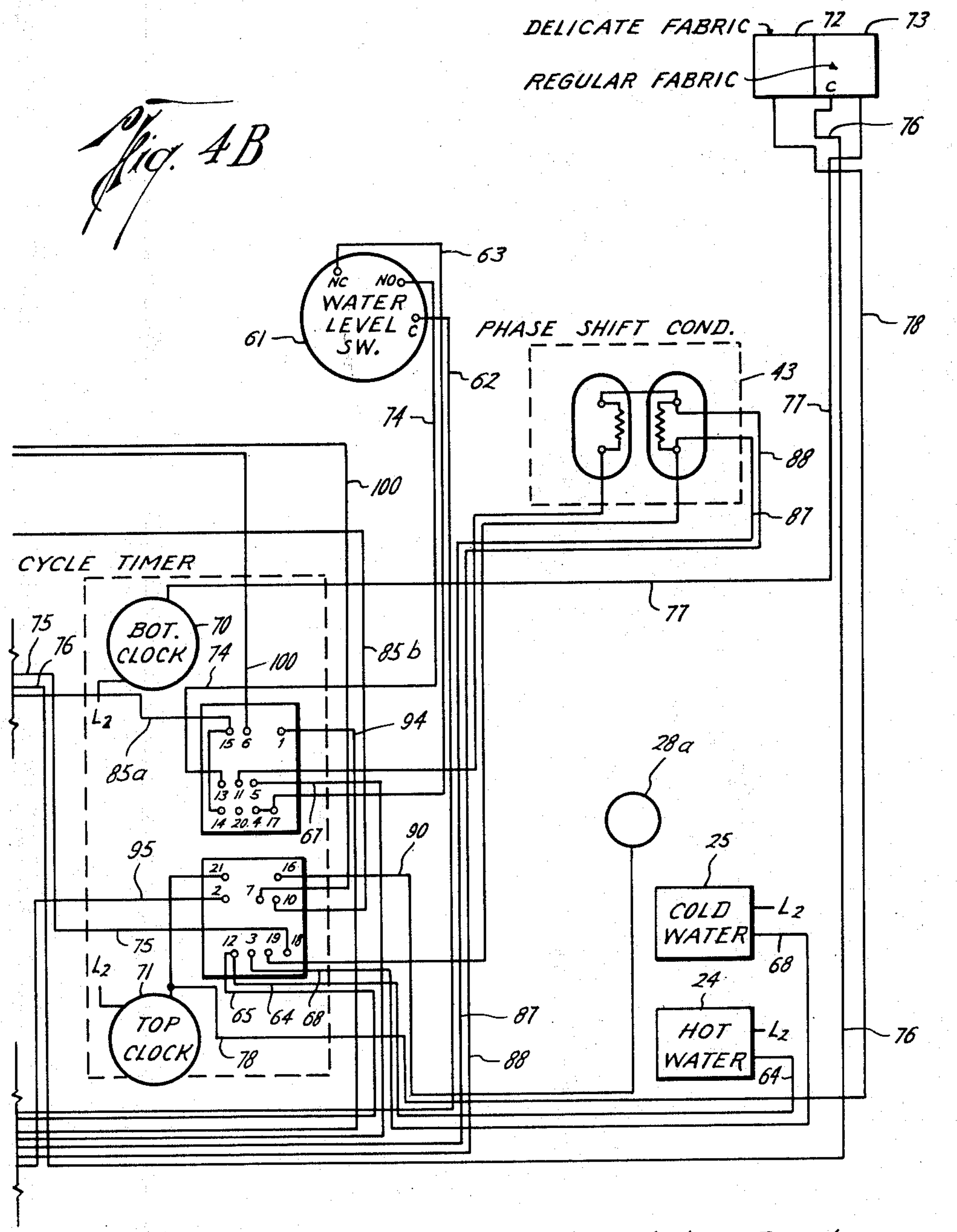

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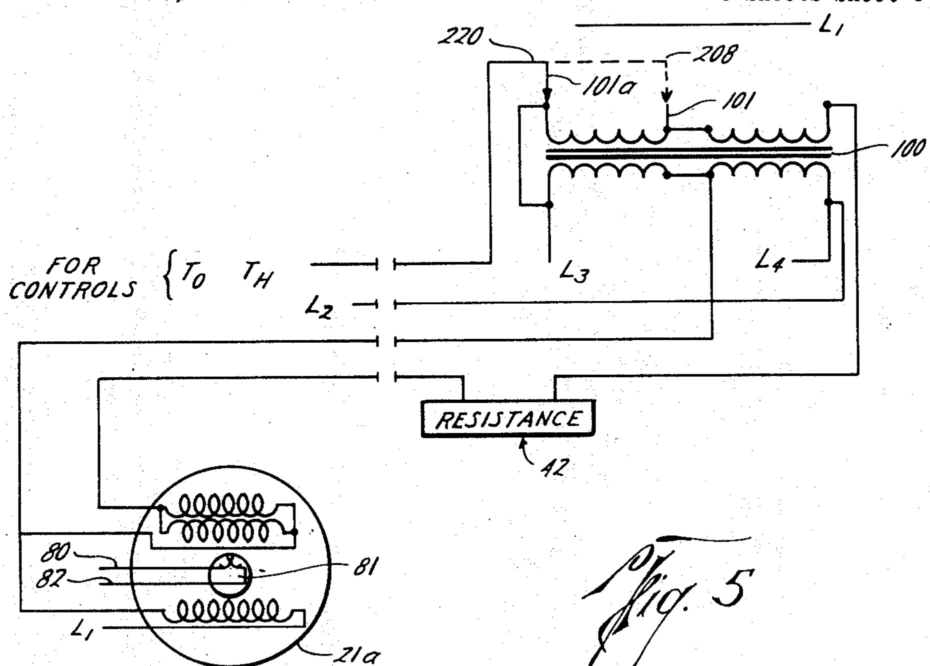

Fig. 5

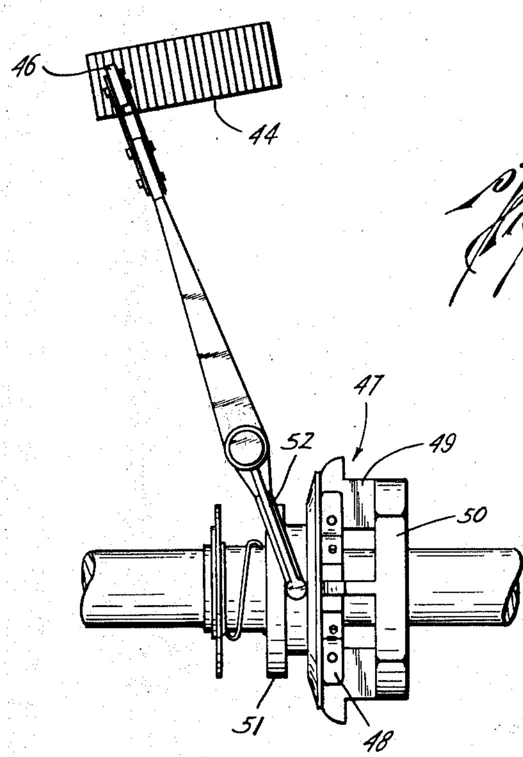

Fig. 6

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LAUNDRY MACHINE

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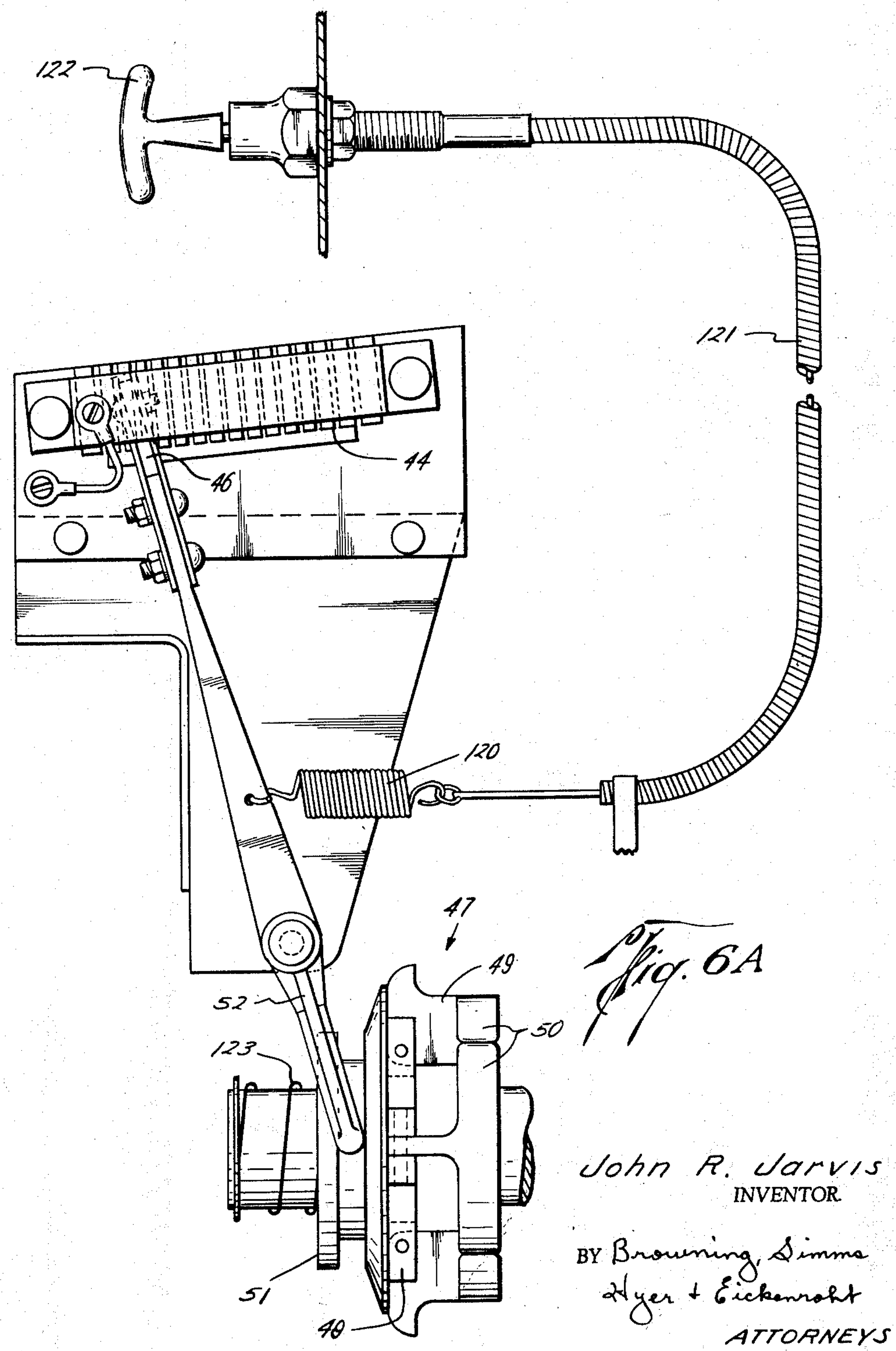

Fig. 6A

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LAUNDRY MACHINE

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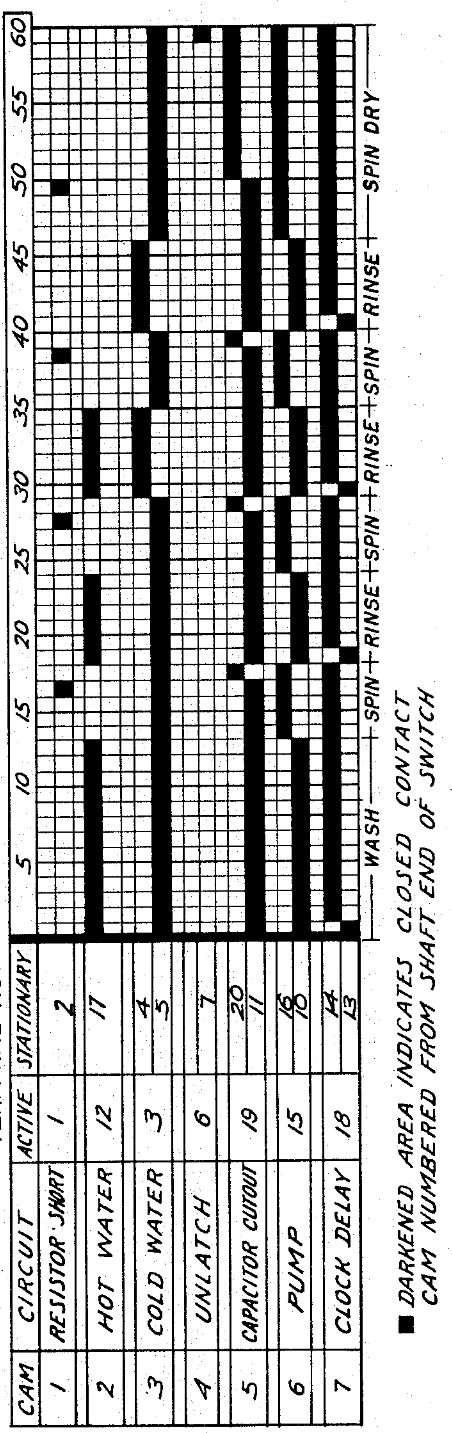

Fig. 8

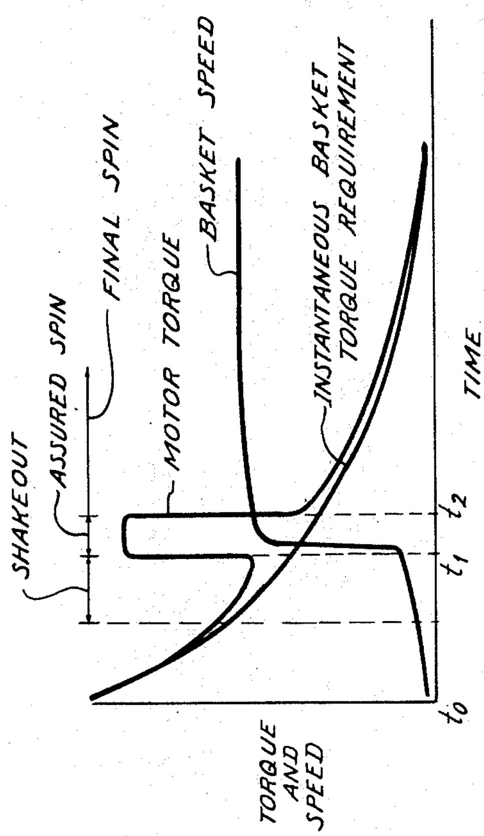

Fig. 7

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United States Patent Office

3,122,009

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3,122,009
LAUNDRY MACHINE

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Filed Oct. 25, 1962, Ser. No. 233,163
17 Claims. (Cl. 68—12)

This invention relates to a laundry machine of the type in which clothes and the like are deposited in a basket which is rotated at different speeds at different portions of the machine's cycle. In one of its aspects, it relates to such a machine in which the basket is direct driven by a variable speed motor in such a way that the operation of the basket and motor are interdependent upon each other so that they cooperate to provide an improved laundry operation. In another of its aspects, it relates to a control system for such a machine in which the device is always prepared for its next cycle of operation even though the preceding cycle may have been interrupted.

This is a continuation-in-part of application Serial No. 199,448, filed June 1, 1962, entitled "Laundry Machine," now abandoned.

In the spinning basket type of laundry machine, the clothes are deposited within the basket which is mounted for rotation inside of a tub. After the tub has been filled with water or other cleaning liquid, the basket is rotated to agitate the clothes and this portion of the cycle is followed by drainage of the liquid from the tub and increasing the speed of rotation of the basket to extract excess liquid from the clothes. This cycle may be repeated a number of times (rinses) followed by a final spin which dries the clothes as much as possible. Obviously, during this cycle, the basket will be at times in an at-rest position, at other times in a medium speed operation and at still other times in a high speed spinning operation. To effect these various basket movements, it has been common to provide various mechanical speed changers between the motor and the basket. Many of these change speed simply by abruptly changing from one machanical drive to another without any intermediate clutching, which results in considerable stresses being placed on the drives due to the inertia of the basket. This has resulted in relatively short lives for such drives. Also, these drives are relatively expensive. Further, the abrupt changes of speed have not resulted in the most efficient washing operation.

Other drives have attempted to utilize a clutching arrangement but these have only added to the cost of the machine without comparable beneficial results.

In these mechanical speed changing types of drives, with or without clutches, the abrupt change in speed between the washing cycle and the spin cycle has created a problem of eccentric loading of the basket with the clothes. The abrupt change of speed does not permit time for the clothes to arrange themselves about the basket so that if a wad of clothes happens to be disposed on one side of the basket when the spin cycle begins, the resulting rapid increase in centrifugal force tends to maintain the wad at that side and does not give the wad time to spread itself out more or less evenly around the periphery of the basket. This, of course, not only results in vibration of the machine but makes it difficult for the wash liquid to be expelled from the wad.

Another problem with machines of this type is that they are time cycle controlled and usually the door to the machine is provided with an interlock switch which cuts off both the motor and the time cycle device when the door is opened in order to minimize the chances of injury to anyone who might wish to inspect the clothes during an intermediate portion in the cycle. In some cases, clothes will be removed before the cycle is com-

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pleted as, for example, after the first or second rinse, and the door will be left open. Then when a new batch of clothes is deposited, the machine will simply complete its cycle and then stop, thereby missing the wash part of the cycle. This problem is particularly bothersome in commercial laundries where the machine is coin-operated. Not only will a customer be dissatisfied with improper operation of the machine but in many cases, may have to pay twice to obtain proper laundry service; i.e., a first payment to complete the cycle and a second payment to obtain a full cycle.

It is therefore an object of this invention to provide a laundry machine in which a basket is direct driven by an electrical motor without any intermediate speed or direction changing mechanisms and in which the speed of the motor driving the basket is controlled electrically by a speed control device and also by the torque reaction of the basket upon the motor.

Another object is to provide such a machine in which the speed of the basket is so controlled that the shake out of the articles in the basket is accomplished between the wash and spin portions of the cycle.

Another object is to provide such a machine wherein the change in basket speed between the wash or rinse portions of the cycle and the spin portion of the cycle is gradual enough to permit shake out of the articles in the basket and is at least partially controlled by the loading conditions on the basket which also affect the degree of shake out.

Another object is to provide such a machine in which even though the motor speed control is such as to permit the loading conditions on the basket to at least partially determine the rate of acceleration of the basket between the wash or rinse portion of the cycle and the spin portion so that the basket is slowly accelerated to permit shake out, nevertheless the speed control will thereafter assure a positive and relatively rapid acceleration of the basket toward its spinning speed to give an "assured" spin.

Another object of the invention is to provide such a machine in which the basket is direct driven by the electric motor and yet in which the direction of rotation of the basket can be cyclically changed with the motor rapidly reversing the direction of rotation of the basket and bringing it back to a desired speed of rotation which is to be automatically maintained until the next reversal of rotation.

Another object of the invention is to provide in such a machine a safety interlock control system which assures that when the access door to the basket is opened before the end of the cycle, not only will the basket be stopped but the time cycle device programming the operation of the laundry machine will have its clock motors time out to the end of a normal cycle without at the same time causing any of the normal operations of the remainder of the cycle to occur, thereby assuring that the machine is in condition to begin a completely new cycle even though the door remains open for the balance of the old cycle.

Other objects, advantages and features of the invention will be apparent to one skilled in the art upon consideration of the specification, the claims and the attached drawings wherein:

FIG. 1 is an elevational view of a preferred embodiment of the invention with certain internal parts shown in dash outline;

FIG. 2 is a vertical cross-sectional view of the machine taken on line 2—2 of FIG. 1;

FIG. 3 is another view partially in section and partially in elevation and taken on the line of 3—3 of FIG. 1;

FIGS. 4A and 4B together constitute a preferred embodiment of a wiring diagram of a control circuit and one which is well adapted for use in the machine of FIGS. 1 to 3;

FIG. 5 is a wiring diagram showing how a three phase motor and an autotransformer can be substituted in the circuit of FIGS. 4A and 4B for the single phase motor shown therein as well as for the phase shift condensers;

FIG. 6 is an enlarged view of a portion of the speed control mechanism for the motor which drives the basket;

FIG. 6A is an enlarged view of the speed control mechanism illustrating an alternate arrangement which allows manual adjustment of the variable speed range;

FIG. 7 is an illustration showing the various relations between motor characteristics, basket torque requirements and basket speed as they vary with time between the end of a wash portion of a cycle to the spin portion of a cycle; and

FIG. 8 is a chart showing the programming of the various events which occur in the preferred illustrated embodiment of this invention as applied to a washing machine.

Like characters of reference will be used throughout the several views to designate like parts.

Referring now to FIGS. 1–3, there is illustrated the over-all arrangement of the mechanical components of the machine although many construction details have been omitted for the sake of clarity. Thus, the machine can include a housing 10 in which a fluid-tight tub 11 is mounted. Inside the tub is disposed a suitable basket 12 which can have the usual circumferential perforated wall permitting liquid in the tub to flow into and out of the basket. At the front of the machine is an access door 13 which can be opened in order to deposit and remove articles from the basket. The basket is mounted for rotation in the housing and in the tub and, in this case, by a shaft 14 journaled by suitable bearings in a support 15 which in turn is carried by a double cone mounting, the inner cone of which, as shown, forms a portion of the tub. The shaft 14 extends from its double cone mounting to carry a spider 17 which in turn is fastened to the rear portion of the basket. The other end of the shaft extends to receive a relatively large pulley 18 which by suitable belt 19 is connected to another and smaller pulley 20 carried by the drive motor 21. It will be noted that pulley 20 is directly mounted on the drive shaft of motor 21 without any intermediate speed change mechanisms. Moreover, the belt 19 forms a direct driving connection between pulleys 18 and 20, also without any speed changing mechanisms. It will therefore be seen that the direction of rotation of the basket is determined solely by the direction of rotation of the motor drive shaft and that the ratio of the rotational speed of the basket to the rotational speed of the motor drive shaft will be a fixed value at all times. This very simple torque transmitting connection between the motor and the basket can, of course, take other forms, such as by substituting sprockets for pulleys 18 and 20 with a suitable chain drive therebetween. This is not as desirable as a belt drive because it would be more expensive, more subject to wear and noisier. Also, pulleys 18 and 20 could be substituted by gears and the motor moved so that the two gears would mesh. Here again, this would be more expensive than the belt drive and could possibly be noisier and there would be a problem of lubrication.

The machine is also shown as having cold and hot water inlets 22 and 23 controlled by solenoid valves 24 and 25. A suitable drain 26 is provided at the bottom of the tub and a conduit 27 connects it with a pump 28 for discharge of the tub liquid via a solenoid valve 28*a*. The pump 28 is driven by a motor 29 which also drives a blower 30 to provide cooling air to the drive motor 21 as will be explained in more detail below. Alternatively, the valve 28*a* can be eliminated and the pump and fan driven by separate motors in which case the pump motor would be turned on and off in the same sequence as described below for opening and closing of the valve.

The machine can also be provided with numerous other fittings such as a soap or detergent chute 31, a coin acceptor-rejector mechanism 32, etc.

As shown in FIGS. 1 and 2, the basket is provided with four internal fins 33*a*, 33*b*, 33*c* and 33*d*. Each of these fins extends approximately one-half the width of the basket and they are spaced at 90 degree intervals with a pair of diametrically opposite fins situated at the rear of the basket and the other pair at the front of the basket. With this arrangement and by turning the basket at a speed such that centrifugal force on the clothes is just sufficient to cause them to cling to the basket wall until they are lifted part way up the side of the tub (e.g. 90°) but not to the top of the tub, the clothes in the basket will have a combined tumbling action and a sliding action upon each other as contrasted to a pure tumbling action as would be the case if they were lifted to the top of the tub to be tumbled down by gravity. This gentle scrubbing action is believed to result in more efficient cleaning in that there is a greater rubbing of clothes one upon the other than would be the case for pure tumbling action.

Motor 21 is of the type described in my U.S. Patent No. 2,666,169, issued January 12, 1954, in that it has a solid iron or steel rotor. By "solid rotor," it is not meant that the rotor must always be a solid steel shaft but rather, that there must be at least a solid steel or iron annular shell forming the armature with the interior of the shell being open except for the necessary supporting web structure connecting it to the motor drive shaft. The field coils should be at least four in number (two windings) and are illustrated as such in FIG. 4A, it being understood that the lower winding is actually two coils. At least one of the windings has line voltage applied across it while another winding is placed across the line but in series with a means for varying the effective electrical power input to the motor. Where a single phase power source is used, such means can take the form of a variable resistor and a capacitance in series with the motor winding. The capacitance serves to shift the phase of the current in such winding with respect to the phase of the current in the winding at fixed line voltage. The variable resistor is employed to govern the amount of effective electrical power input to the variable voltage winding and thereby govern the torque output of the motor. Thus, with the motor connected to the basket which is in an at-rest position, and with the series variable resistance at a minimum or zero value, application of power to the motor will cause it to exert its maximum torque to accelerate the basket. As the motor and basket speed increases, the torque required to accelerate the basket will decrease and a corresponding increase in the series resistance will cause less effective electrical power to be applied to the motor so that the basket will be smoothly accelerated. If the variable resistance is increased at the proper rate, a point will be reached where the torque output of the motor just balances the torque required to maintain the basket rotating at a constant speed (the mechanical advantage of the drive between the motor and basket being taken into account). By making the resistance change gradual, the balance point can be reached without any abrupt change in torque such as would be experienced with a mechanical speed changer.

If for some reason the torque required to maintain the basket at its desired speed should increase, the motor will tend to slow down and a corresponding decrease in the series resistance will cause it to increase its torque output to speed the basket back up to the desired speed. If the torque required for basket rotation should decrease, the resulting speed-up in the motor requires that the series resistance be increased so that the motor will slow back down to the desired basket speed. Thus, it will be seen that by properly matching the rate of change of the series resistance with the torque requirement for turning the basket, the basket can be brought to a predetermined speed and maintained there. It will also be seen that variations in basket torque requirements will be reflected back into corresponding variations in motor speed which in turn can govern the change in resistance to maintain the basket speed constant.

Turning now to the drawings wherein a single phase, 230 volt, 60 cycle per second system is illustrated, the fixed voltage winding of motor **21** is shown at **40** and the phase-shifted, variable voltage winding at **41** (FIG. 4A). The series variable resistance is shown at **42** and the phase shift condensers at **43** (FIG. 4B). The variable resistance can be composed of a number of resistances wired in series with each other with each respectively wired in parallel across the segments of a commutator **44**. As a typical illustration, the values of the resistors R_1 through R_{11} in FIG. 4A can be as follows:

	Ohms
R_1	2
R_2	2.25
R_3	3
R_4	3.5
R_5	4
R_6	4.5
R_7	5
R_8	6
R_9	20
R_{10}	30
R_{11}	40

Since the heat load to be dissipated by the resistors can be quite substantial, they should be of ample wattage and provision can be made for their cooling. One preferred way of doing this is to provide the resistances in the form of a coil of a nicron wire *42a* (FIG. 1) which can be tapped to provide the various resistance values. This wire can be mounted in a ceramic disc *42b* in much the same manner as are the heating elements for electrical stoves. To further aid in dissipating the heat, the blower **30** (FIG. 3) can be hooked by a suitable duct **44** to a housing **45** between motor **21** and the resistance mounting *42b*. Air can then be blown through the resistance mounting, which can be imperforate, and at the same time, a part of the air can be blown the other way through the motor to cool the same. This is desirable because the rotor of the motor has a high resistance and therefore will be required to dissipate considerable heat.

As indicated in FIG. 4A, the segmented commutator is contacted by a wiper **46**. As shown in FIG. 6, the wiper position is governed by the speed of the motor through a suitable fly ball actuator **47** carried by the motor drive shaft. This actuator is here illustrated as comprising a fly ball carrier **48** fixed to the motor shaft and carrying fly ball elements **49** which are pivoted thereto for outward movement of their weighted ends **50** as the motor increases speed. As this happens, the fly ball elements push a collar **51** along the shaft and, through a yoke **52** riding in the collar, cause the wiper to move to the right as shown in FIG. 6. Therefore, assuming that the left hand side of the commutator, as shown in FIG. 6, is the low resistance end, there will be a minimum series resistance in the motor circuit when the motor has stopped and this resistance will increase as the motor speed increases, finally reaching a maximum when the wiper has moved to the right-most position.

FIG. 6A illustrates an alternate arrangement of the fly ball actuator which provides means for adjusting the position of the wiper arm for a given shaft speed. This is frequently necessary since conditions change in all machines as they are used due to wear, loss of lubricant, etc. The adjustment means consists of the coiled spring **120** which is connected to wiper **46** and the flexible cable **121**. The flexible cable is properly mounted so that the spring can be easily adjusted by manipulation of the handle **122** located outside the machine.

In fly ball actuators of the type illustrated the position of the fly ball element **49** for any given shaft speed is determined by the strength of the spring **123**. By exerting an additional force on spring **123** by means of the spring **120**, the minimum speed required to move the wiper **46** is reduced since the wiper moves toward the spring **120** as the shaft speed increases, thereby decreasing the force it exerts on the wiper. The spring can be adjusted to either simply reduce the shaft speed required to move the wiper from the lower end of the commutator, after which time it will have little or no effect, or it can be stressed to the point where it will shift the entire speed range of the actuator. By using the arrangement illustrated in FIG. 6A, either fine or large adjustments can be made in the speed control system easily and quickly at any time during the life of the machine.

It will be noted that the resistance values vary by small steps in R_1 through R_8, and R_9 through R_{11} increase by much larger steps. This is due to several factors. First, the torque versus speed characteristics of the motor are nonlinear. Second, the force exerted by the fly balls versus the spring is nonlinear and for any given amount of movement of the wiper, the speed change of the motor must become ever larger as the motor speed increases. Third, the basket load is nonlinear. Fourth, it is desired that the speed change be gradual while the tub is draining to allow for shake out but once this has occurred, that there be a significant increase in speed to hold the shaken out clothes in place. Hence, the resistance is sized so that an abrupt torque change occurs as the wiper moves from R_8 to R_9, and R_6 through R_8 are sized so that the shake out will occur in this range. Also, R_1 through R_8 are sized so that the motor speed will tend to be constant during the wash and rinse portions of the cycle despite variations in basket loading and line voltage. For any given application, specific resistance values can best be determined by mere routine test.

It will therefore be seen that when the tub has been filled, the motor will apply a maximum torque to initiate rotation of the basket and that as the basket torque requirement decreases, the motor torque will decrease (or, in other words, the effective power input to the motor will decrease) at a faster rate until the two torques just balance (mechanical advantages being taken into account). If it is desired to reverse the basket rotation cyclically, this can be done by a mechanism which reverses the leads to the motor cyclically. After the basket has stopped, the motor applies maximum torque to accelerate the basket in its new rotational direction until the torque balance is again reached. This permits rapid reversal of basket movement (e.g. twelve times per minute in a 25 pound machine whereas with a conventional motor and drive, the limit is about 3 times per minute).

When each wash and rinse cycle is completed, the liquid can be drained from the basket. As it drains, the basket torque requirement decreases so that it will tend to speed up. By arranging the resistance so that the resulting rate of increase in resistance value is less than the rate of change of basket torque requirement, the basket will be slowly accelerated. It is during this period of slow acceleration that the clothes go through a shake out. This action is illustrated in FIG. 7 where the time interval t_0–t_1 shows a gradual increase in basket speed and a gradual increase in motor torque relative to the instantaneous basket torque value required to maintain the basket at a given constant speed at any instant of time. The gradual departure of the motor torque from the instantaneous basket torque requirement is a measure of basket acceleration.

From FIG. 7, it will be seen that the increasing motor torque in the interval t_0–t_1 may eventually accelerate the basket to its full spin speed. However, to shorten the acceleration time and to give an "assured" spin, at least a portion of the resistance is shorted from the motor circuit at time t_1. Then the increased motor torque in the interval t_1–t_2 rapidly accelerates the basket toward full spin speed. At time t_2, the short can be removed and the variable resistance will again be in the motor circuit but the basket torque requirement is now so low that the full resistance will still allow a motor torque in excess of the basket torque requirements. At about time t_2, the external capacity can be reduced, as by opening one or more of the external capacitors, and this will tend to cause the motor to attain its full speed. This is due to the fact that with the capacitors in the circuit, and as the speed increases, the inductance of the motor windings will increase. The capacitance effect then results in increased winding voltage. By opening one or more of the capacitors, the voltage increase is limited and this helps keep the flux density more equalized between the motor winding to obtain greater speed.

In order to clearly describe the circuit of FIGS. 4A and 4B, it is thought best to describe the components and their function in the circuit at the same time rather than separately. Also, to simplify the circuit, all the return wires have been eliminated and the short return stubs labeled "L_2" are intended to indicate the returns.

In the illustrated embodiment, the machine is of the coin-operated variety and there is shown a coin accumulator and coin switch which can be of the type shown in co-pending application Serial No. 131,301, filed August 14, 1961, and as shown in the advertising literature of Meter-All Mfg. Co., Inc., Dallas, Texas. Thus, a coin switch 50 is connected to terminal strip T_H (which is the hot terminal) and also to the coil of a ratchet solenoid 51. The coin switch 50 is of the type that closes when a coin is dropped therethrough so that it sends a pulse to the ratchet solenoid 51. This causes a ratchet wheel (not shown) to be stepped one step. Then when a suitable number of coins has been deposited, the ratchet wheel will close the normally open contacts of switch 52, thereby completing the circuit from T_H via wires 53 and 53*a* to terminal strip T_1. This completes the circuit of the fan and blower motor 29 via wire 54 to start the fan and blower running.

Energization of T_1 also energizes switches 57 and 58 via wire 59. Switches 57 and 58 are door switches and are shown in FIG. 3 as mounted so that they are actuated responsive to opening and closing of the access door to the basket. Thus, with the door closed, the switch contacts are reversed from the positions shown, which are for the door open. Then upon energization of the normally open contacts of switch 57, and with the door closed, terminal strip T_2 is energized via wire 60. This in turn energizes the common of water level switch 61 via a wire 62. Water level switch 61 is illustrated as of the pressure sensitive type and is connected, as shown in FIG. 2, to the drain from the tub. Thus, when the water level in the tube rises to a predetermined height, the switch will reverse its contacts.

With the tub empty, stationary terminal 17 of the cycle timer is energized via wire 63. At this point, it should be explained that the cycle timer is of a well known construction and hence, is only schematically shown in FIG. 4B. The illustrated timer has a number of "active" contacts (Nos. 1, 3, 6, 12, 15, 18 and 19) which are adapted to be closed upon certain stationary contacts by cams arranged to give the sequence shown in FIG. 8.

At the start of the cycle, terminal 17 is in contact with active terminal 12 and this energizes the hot water solenoid valve 24 to cause hot water to start flowing into the machine. At the same time, if the temperature selector 66 is set on "warm water," the circuit to selector 66 and the cold water solenoid 25 in series therewith is completed via wires 65 and 67, terminal 5 (which at this time is closed on terminal 3) and wire 68 to open the cold water solenoid valve 25.

At the same time, the reversing timer clock 85 is started by energization of T_1 via wire 85*a*, closed cycle timer contacts 10 and 15, and wire 85*b*. The purpose of this clock motor is to cyclically reverse the leads to the main motor so that the basket will be periodically reversed in rotation.

As soon as the tub is filled to the desired level, switch 61 will reverse its contacts and this will start one of the clock motors 70 or 71. These clock motors are in effect wired in parallel with each other and respectively in series with one of the fabric switches 72 or 73. By making the clock motors of different speeds, a shorter wash cycle can be selected for the delicate fabrics and a longer wash cycle for the regular fabrics. The circuit is as follows: wire 74 to terminal 13 which is now closed on terminal 18 (FIG. 8), wire 75 to the normally open contacts of switch 58 (now closed because the door is closed), wire 76 to the common of the fabric switches, wire 77 to clock 70. Should the fabric switch be set in the delicate fabric position, instead of wire 77 being energized, wire 78 will be energized to start clock 71.

Reversing of the contacts of the water level switch also causes the motor relay 69 to be actuated to apply power to motor 21. The circuit for this is via wire 80, which is connected to wire 75 which in turn has been energized due to closing of the normally open contacts on the water level switch 61, to the motor protector 81 and thence via wire 82 to the coil of relay 69. The current for the motor is supplied to the relay via wire 83 from T_H. The other contacts of the relay are connected to a reversing timer mechanism 84 which in turn is driven by the clock motor 85. The reversing timer mechanism is comprised of one pair of single pole, single throw switches 84*a*—84*b* and one pair of single pole, double throw switches 84*c*—84*d*, all of which are coin-operated by clock motor 85. The sequence is: switches 84*a*—84*b* open to remove line voltage and then switches 84*c*—84*d* reverse their contacts and then switches 84*a*—84*b* close. This permits the switches 84*c*—84*d* to make and break without line voltage across them which would cause arcing.

The circuit for the main drive motor 21 and its controls is as follows: wire 86 to coils 41, then wires 87 to the phase shift capacitors 43 and thence wire 88 to the input side of variable resistance 42 and thence wire 89 back to the reversing timer mechanism. The coils 41 are thereby connected in series with the variable resistance and the capacitors.

As shown in FIG. 8, after one time interval, the water level switch 61 is shunted by the cycle timer which in turn locks in the motor relay. This is accomplished by opening of terminals 13 and 18 but again closing terminal 18 on terminal 14 which, as will be recalled, is energized via switches 57 and 58 from terminal T_1.

At the end of the wash cycle, the cycle timer interrupts the circuit through the timer to the clock motor 85 by opening timer terminals 15 and 10 and at the same time making timer terminals 15 and 16, which energize wire 90, to start open solenoid dump valve 28*a*. In order to avoid the possibility that the reversing timer mechanism will be stopped with switches 84*a*—84*b* open and to assure that the basket will always be turned in the same (forward) direction during the spin cycle, a circuit is provided to assure that if the cycle timer cuts off the clock motor 85 while the main motor is rotating in a reverse direction or while switches 84*a*—84*b* are open, the reversing timer mechanism will continue to operate until the motor has been reversed and the switches closed. This circuit includes a switch 92 whose common is connected via wire 93 to terminal T_2. The switch is opened and closed by a cam in the timer mechanism in such a manner that its normally closed contacts will be closed during the time the motor is rotating in a reverse direction. Then if the cycle timer should open its circuit to clock motor 85 while the motor is rotating in a reverse direction or while the switches 84*a*—84*b* are open, there will still be a closed clock motor circuit via wire 93 and the close contacts of switch 92 and wire 85*b*′ to the clock motor causing it to continue to run until it reverses the direction of the motor and closes switches 84*a*—84*b*, at which time the cam in the timer mechanism will open switch 92 and stop the clock motor.

About the time the last liquid is pumped from the tub, the cycle timer closes its terminals **1** and **2** which, via wires 94 and 95, effectively shunt out R_9—R_{11}. Since by this time the wiper 46 has been moved on the commutator to be in a position to sense these resistances, the shunting reduces the resistance the motor circuit would otherwise see and motor output torque is substantially increased so that the basket is rapidly accelerated toward its spinning speed. After the basket has been substantially accelerated, the resistance shorting terminals **1** and **2** of the cycle timer open and at about the same time, terminals **19** and **20** open, thus effectively opening one of the two phase shift condensers. All of this action is illustrated in FIG. 8.

At this point, it should be noted that with the control system of this invention, if the load in the basket is balanced during its spin cycle, the torque requirement for spinning the basket will be relatively low and the basket will achieve maximum speed. However, if for some reason the load in the basket is markedly unbalanced, a higher torque will be required to spin the basket and this requirement is reflected back to the motor whereby it causes the basket to rotate at a lower speed. This limits vibration due to eccentric loading of the basket.

At the end of the first wash and spin cycle, the above described operation is repeated for the first rinse except only that the cycle is made shorter as illustrated in FIG. 8. It will be noted that FIG. 8 shows that during the first rinse, cycle timer contacts **3** and **4** are made and this results in the water level switch 61 opening the cold water solenoid if the selector switch 66 is set on "warm" water—otherwise, the first rinse is of hot water only. On the second rinse, the cycle timer opens the cold water solenoid so that this rinse is always with warm water, no matter how switch 66 is set. Further, the third rinse is always with cold water.

After the desired number of rinse cycles has been made, the machine will go into a final spin as shown in FIG. 8 and this spin is accomplished in the same manner as preceding spins and the only difference is that its duration is longer. At the end of the final spin, cycle timer contacts **6** and **7** close and this completes a circuit to the unlatch solenoid which causes the coin accumulator to be actuated so that switch 52 is returned to its normal position, thereby shutting off the machine. The unlatching circuit includes wire 100 from T_H to point **7** and wire 101 to the unlatch solenoid from point **6**.

FIG. 5 shows a 220 volt, three phase motor and motor control wiring diagram which can be substituted for the single phase system of FIGS. 4A and 4B. Here, an autotransformer 100 is connected to a three phase motor **21*a*** with a variable resistance 42 (which can be constructed as shown in FIGS. 4A and 6) in one of the transformer legs to vary the resistance in the motor circuit. L_1, L_3 and L_4 are the three phases of the supply and instrument power is taken off as shown. In this connection, a tap 101 is provided so that when 208 volts is supplied, the control tap-off is at 220 volts for the control's voltage. However, when the supply is 220 volts, the tap is at **101*a*** to give 220 volt control supply.

Also, the three phase supply for a two phase motor as shown in my above-identified patent can be used. Further, especially where high motor speeds may be involved, a variable tapped autotransformer, such as is shown in my above noted patent, can be substituted for both the variable resistance and the capacitors (or the autotransformer 100), using the fly ball regulator to move the wiper along the transformer taps.

While specific reference has been made to a washing machine, the principles of this invention are also applicable to extractors, vertical tub machines, and in fact, any laundry device having a basket which is to be rotated at different speeds.

From the foregoing, it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. In a laundry device, a support, a basket mounted for rotation on said support and adapted to receive clothing and other articles to be treated in the basket, a drive motor, means providing a direct torque transmitting connection between the motor and basket such that the ratio of motor speed to basket speed is a constant value at all times and the direction of basket rotation is dependent solely upon the direction of motor rotation, means responsive to the speed of the motor for varying the effective electrical power input to the motor so that (*a*) when the torque required to accelerate the basket to a first speed is relatively high, the motor has a relatively high torque output, and (*b*) when the basket has been accelerated to said first speed and the basket torque requirement decreased, the effective power input to the motor is decreased until the tendency is to drive the basket at said first speed, and (*c*) when the basket is to be spun at a second and higher speed, the effective power input is decreased at a rate which is less than the rate of decrease of torque required to accelerate said basket from its first to its second speed.

2. The device of claim 1 wherein said means for varying the motor power input includes a variable resistance connected in the motor circuit and also a means to short out at least a part of the resistance during at least a portion of the period when the basket is being accelerated from its first to its second speed to increase the torque output of the motor and assure the basket will be spun at said second speed.

3. The device of claim 2 wherein said means to short is effective only during the latter part of the basket's acceleration to thereby provide a gradual acceleration during the initial portion of said period for shake out of the clothing or other articles during said initial portion.

4. The device of claim 2 wherein a capacitance is provided in series with said resistance and wherein a means is provided to reduce the effective capacitance in the motor circuit after the basket has been accelerated substantially toward its second speed to tend to balance the flux in said motor.

5. The device of claim 2 wherein a transformer is connected in the motor circuit with said resistance being in series with one leg of the transformer's connection to the motor.

6. In a laundry device, a support, a basket mounted for rotation on the support and adapted to receive clothing and other articles to be treated in the basket, time cycle means for controlling the operation of the device, means for emitting liquid to at least partially fill the basket and for draining liquid from the basket responsive to a signal from the time cycle means, a drive motor, means providing a direct torque transmitting connection between the motor and basket such that the ratio of motor speed to basket speed is a constant value at all times and the direction of basket rotation is dependent solely upon the direction of motor rotation, means responsive to speed of the motor for decreasing the effective electrical power input to the motor with increasing

motor speed so that the motor speed is dependent upon the torque required to rotate the basket whereby when the basket has liquid in it and its torque requirement is relatively high, the motor will tend to rotate it at a lower speed but as the liquid is drained from the basket and its torque requirement decreases, the motor tends to accelerate the basket to a higher speed.

7. The device of claim 6 in combination with means for cyclically reversing the motor during the period when the basket has liquid in it.

8. The device of claim 6 wherein the power decreasing means includes a variable resistance connected in the motor circuit and having its resistance effective in said circuit increased with increasing motor speed, said resistance being sized so that the rate of decrease of effective power applied to the motor is less than the rate of decrease of torque required to accelerate the basket from said lower to said higher speed.

9. The device of claim 8 wherein means are provided to short out at least a part of said resistance during an interval when the motor is being accelerated from said lower to said higher speed to thereby increase the torque output of the motor to assure a positive acceleration of said basket.

10. The device of claim 8 wherein said means for shorting become operative only after a period following actuation of the means for draining liquid from the basket, said period being sufficiently long to permit a shake out of clothing or other articles in the basket.

11. The device of claim 10 wherein a capacitance is connected in series with said resistance and means are provided for reducing the capacitance after the resistance shorting means ceases to short the resistance.

12. The device of claim 10 wherein a transformer is connected in the power supply to the motor, said resistance being in series with one leg of the transformer's connections to the motor.

13. The device of claim 8 wherein said resistance includes a segmented commutator, a plurality of resistances connected in series with each other and respectively to succeeding ones of the commutated segments, a wiper movable across the commutator, and a fly ball regulator driven by the motor and connected to the wiper to move it responsive to changes in the speed of the motor.

14. The device of claim 13 in which the fly ball regulator comprises cam means arranged to be rotated by centrifugal force, a cam follower which is moved longitudinally by the rotating cam means and which engages the commutator wiper thereby moving it across the commutator as a result of the movement of the cam means, and resilient means resisting the movement of the cam means.

15. The device of claim 14 in which the resilient means is adjustable.

16. The device of claim 15 in which the adjustable resilient means comprises a non-adjustable resilient member engaging the cam follower and an adjustable resilient member connected to the commutator wiper arm.

17. A laundry device, a support, a basket mounted for rotation on the support and adapted to receive clothing and other articles to be treated in the basket, time cycle means for controlling the operation of the device, means for emitting liquid to at least partially fill the basket and for draining liquid from the basket responsive to a signal from the time cycle means, a drive motor, means providing a direct torque transmitting connection between the motor and basket such that the ratio of motor speed to basket speed is of constant value at all times and the direction of basket rotation is dependent solely upon the direction of motor rotation, means responsive to speed of the motor for decreasing the effective electrical power input to the motor with increasing motor speed so that the motor speed is dependent upon the torque requirement to rotate the basket when the basket has liquid in it and as torque requirement is relatively high, the motor will tend to rotate it at a lower speed but as the liquid is drained from the basket and its torque requirement decreases, the motor tends to accelerate the basket to a higher speed, and means for rapidly increasing the effective electrical power input to the motor after a finite period of time after the draining means has been actuated to drain the basket and then decreasing the power input after the basket has essentially increased in speed, so that a period of relatively slow acceleration of the basket occurs during at least a portion of the time the liquid is draining from the basket, affording a shake out period followed by a rapid acceleration of the basket toward its higher speed.

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